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Dialysis to Electron Spin Resonance

some shades, there may be loss in color value by this method, but the better appearance of the goods warrants the loss in depth. The new line of water-soluble sulfurs is particularly useful in continuous application. These dyes may be padded, dried, and then reduced by padding in a bath of soda ash and sodium sulfide and may then be reduced in a steamer. After steaming, the goods are finished by conventional methods.

Vat Dyes

Vat dyes have a long history of use in the textile world. (See also Vol. 2, pp. 517, 894.) Garments and blankets found in the tombs of Egypt show the use of indigo, a vat dye, thousands of years ago (see Dyes, natural). In 1897 Adolf von Baeyer produced synthetic indigo, thus starting the rapid growth of vat dyes. In 1901 René Bohn discovered indanthrone (see Vol. 2, p. 453), the first anthraquinone dyestuff of commercial importance. With the discovery of indanthrone a whole line of dyestuffs, in an entire range of shades, was soon developed.

Chemically, vat dyes are water-insoluble organic substances that possess the unique property of being reducible in alkaline solution to a water-soluble form, which is substantive toward cellulosic fibers. The alkaline solution used to cause the reduction contains sodium hydrosulfite, $Na_2S_2O_4$, and caustic soda. An examination of the mechanism of the vat-dyeing process shows that the reduced vat dye ions diffuse into the fiber and are coordinately bonded to the cellulose molecule by hydrogen bonds and van der Waals forces. When the reduced dye is oxidized it becomes water-insoluble; however, it is now mechanically trapped within the fiber. Examination of a dyed cellulosic fiber will show that the oxidized vat dye particle has considerable freedom within the fiber.

Vat dyes can be divided into two groups, the anthraquinone and the indigoid types. The anthraquinone type is the more widely used. The dyes of this type exhibit superior fastness properties. Dyes of the indigoid type have excellent fastness to washing and bleaching; however, they may possess poor fastness to light in many applications. A few of the indigoid derivatives exhibit outstanding brilliance of shade. Occasionally, the lower cost of indigoid dyes (qv) may account for their use.

VATTING

When a vat dye is treated with a strong reducing agent in the presence of alkali, it acquires affinity for cellulosic fiber. This phenomenon is known as vat reduction, or vatting, and is accomplished by the reduction of a pair of carbonyl groups. This reaction is illustrated in the following equations for indigo and for an anthraquinone vat dye (Anthraquinone Vat Yellow GK; CI Vat Yellow 4):